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This reprint from "American Education" contains five articles on the future of computers in education. The first article presents the advantages of using centrally operated facilities in school districts; the advantages of offering courses in computer technology to high school students; and some of the capabilities of computers for improving instruction, such as grading, flexible scheduling, special education, and planning. The second article deals with the virtues of computer-assisted instruction (CAI) and with the changes in teachers' roles which accompany the utilization of CAI. The third article details five ways to use computers in education: career guidance, systematic long range building planning, medical simulations, CAI, and paperwork organization and acceleration. The fourth article stresses the need for awareness of the capabilities of computers in education, and the fifth deals with computer-related activities which are supported by federal funds. (SM)

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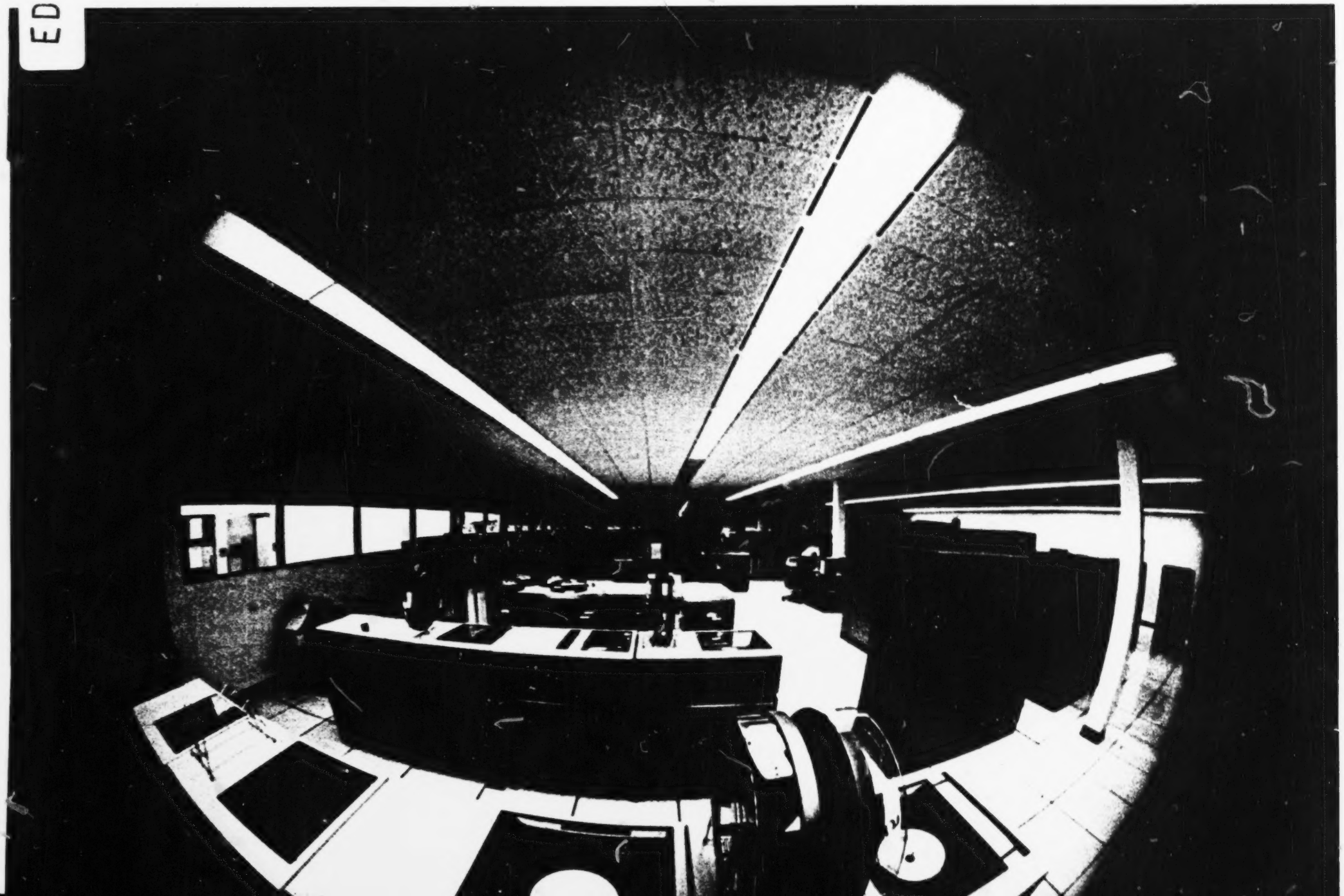

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COMPUTER

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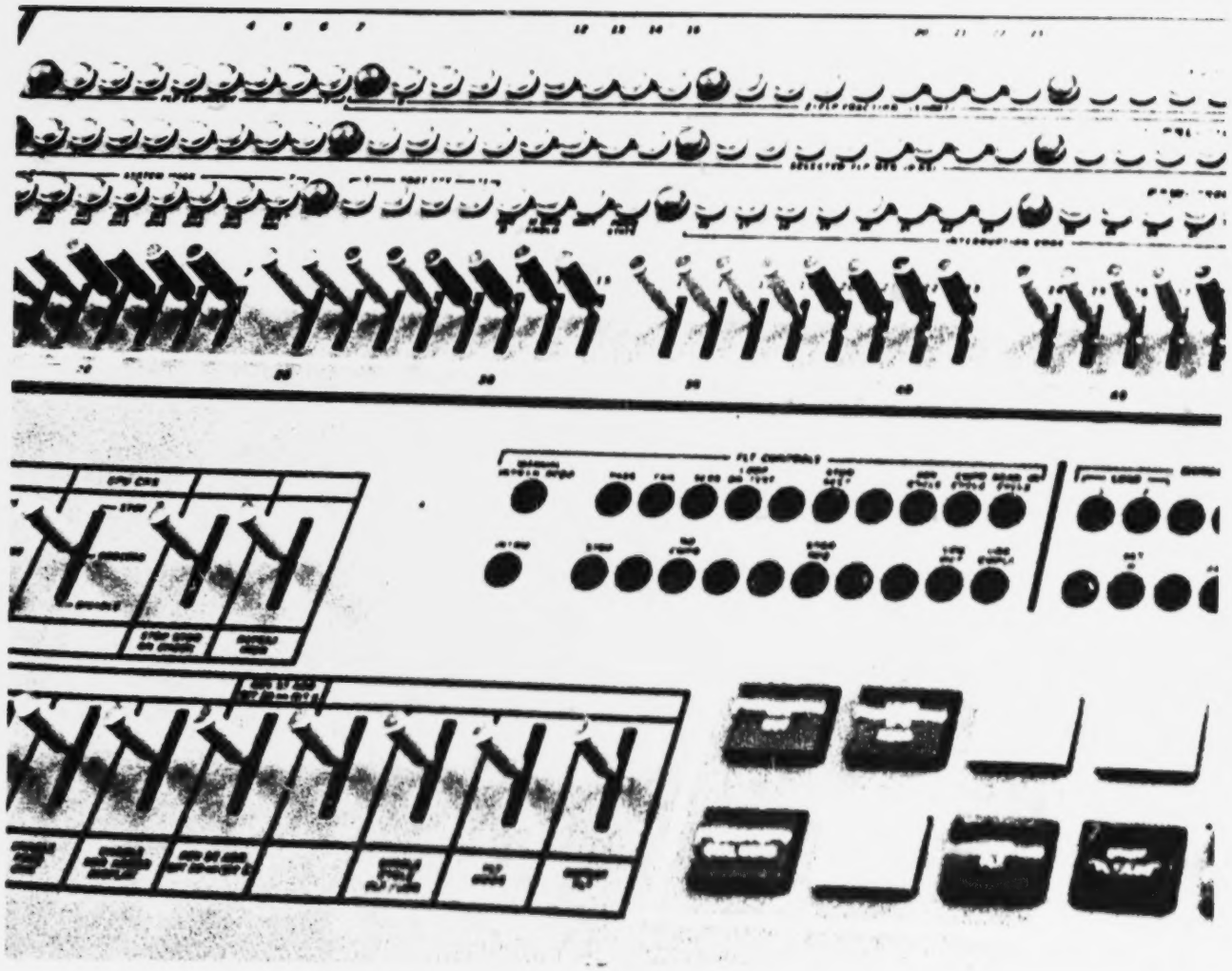

The time is now

By R. LOUIS BRIGHT

We are rapidly becoming a computer-assisted society. Few areas of our lives are not affected by these amazing machines which appeared less than 20 years ago. Already they schedule vast steel mills, train leaders of business, check income tax returns, and guide rockets to Venus. College students are even using them for the most personal of matters—to find dates for themselves.

What does this mean for educators? It means that unless high schools and colleges start telling their students how their lives and work will be changed by computers they are selling them short. A report from the President's Office of Science and Technology on use of computers in higher education asserts that any four-year liberal arts college that does not give students experience in

The computer would give these schools three things for their money: it would provide routine administrative services, offer instructional support for computer job training, and give every student in those schools the opportunity to learn how to use modern data processing techniques.

This computer would help both the elementary and high schools with administrative tasks—recordkeeping, testing, and even scheduling. Certainly, this would save time and money for the school system but the greatest benefits would fall to the students, largely to those in the secondary grades. Through remote terminals, either teletype machines or fast card readers, students could be taught data processing skills. They could learn

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Some computerized techniques are within reach of the average high school and college right now. A study supported by the Office of Education's Bureau of Research shows that if several schools use the same computer facility, it would cost an average school district no more than one percent of its total budget to take advantage of several important computer applications. For example, figures indicate that to serve 120,000 elementary pupils, 40,000 secondary schoolers, and 2,000 college students, the cost of equipment, personnel, and supplies would run about $800,000 per year. For a district with 486,000 students, the cost would be about $1.7 million annually. These amazingly low figures were drawn from a study of the cost of servicing 50 high schools and junior colleges with a central computer facility.

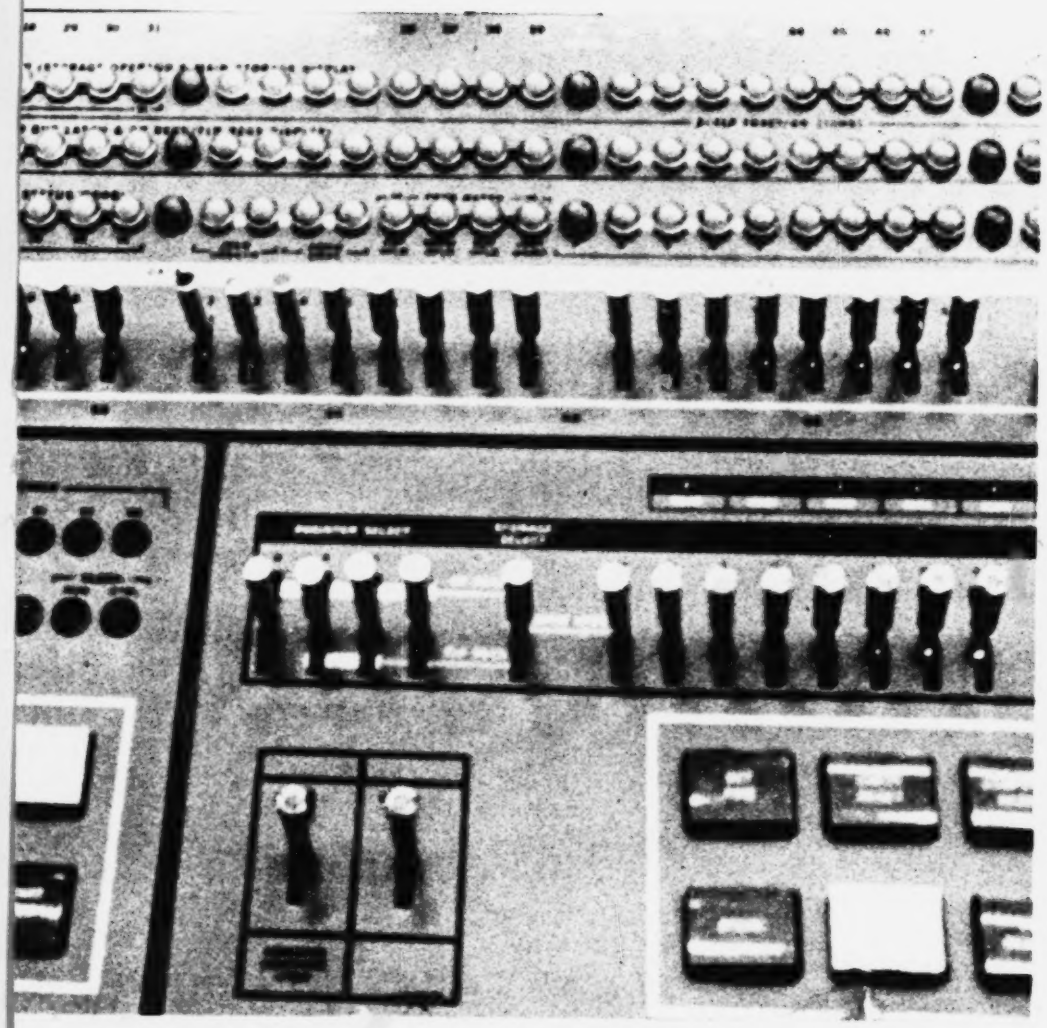
This is no vague, futuristic supposition; it is a very practical system that conceivably could be operating within two years. The secret of its success is the regional approach. One computer would serve school districts for one hundred miles around. The computer would give these schools three things for their money: it would provide routine administrative services, offer instructional support for computer job training, and give every student in those schools the opportunity to learn how to use modern data processing techniques.

This computer would help both the elementary and high schools with administrative tasks—recordkeeping, testing, and even scheduling. Certainly, this would save time and money for the school system but the greatest benefits would fall to the students, largely to those in the secondary grades. Through remote terminals, either teletype machines or fast card readers, students could be taught data processing skills. They could learn the symbolic languages that must be fed into the machines and experiment with high-level programing.

Vocational students could learn these skills in greater depth along with the related skills of business systems analysis, file manipulations, etc. Public education can perform one of its greatest services for the disadvantaged by training them in computer jobs. Few of these jobs require more than a high school education. Industry hires college graduates for its computer training programs not because the positions demand this higher education but because college graduates are usually easier to train.

Regardless of their career plans, all the students would have some contact with the computer system. For instance, they could feed math, physics, and statistical problems into the machine and get rapid-fire solutions. With this kind of a start, students will think of using the computer to solve realistic problems all their lives.

This is extremely important for future professionals who may find their jobs in the process of transformation as soon as they graduate from college. Computers have already made drastic changes in management and engineering, and soon they will be affecting law, medicine, science, architec-



ture, and education. It's hard to imagine a field which won't be nudged by the computer. Students have to be prepared to face this challenge. It is an enormous task; no university is even close to meeting it.

But computers will touch far more of the average citizen's life than his job. It is up to the schools to make him feel comfortable with these ubiquitous machines. There is a psychological barrier here. At an eastern junior college last year, the computer's advent led to angry strikes by students who objected to the impersonalization of just becoming numbers in a strange machine somewhere in the basement of the administration building. They were probably mistaken; computer scheduling systems can actually counter

This feasibility study indicates one of the greatest contributions research can make to education today. It will help schoolmen determine from the vast amount of educational technology available what is economically sensible and what is just educationally nice to have, at least at this point. Now we know that some computer services can be made available to schools at a price they can afford: still in the offing are computer-assisted instruction and numerous other applications of technology that will eventually be within reach of the school system.

Nevertheless, educators should keep an eye on some of the more exotic computer applications because these, too, may be economically feasible in the next decade. On the administrative scene,

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In the realm of testing, the computer has two great advantages: it can make standardized tests truly standardized—each child receives test instructions in the same tone of voice—and it can skip large blocks of questions that are clearly too easy or too difficult for the student. The machine automatically selects question areas which point up the student's weak points and prescribes study materials he needs. This has special value in testing students with diverse backgrounds—first graders, high school remedial groups, and adults.

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But computers will touch far more of the average citizen's life than his job. It is up to the schools to make him feel comfortable with these ubiquitous machines. There is a psychological barrier here. At an eastern junior college last year, the computer's advent led to angry strikes by students who objected to the impersonalization of just becoming numbers in a strange machine somewhere in the basement of the administration building. They were probably mistaken; computer scheduling systems can actually counter impersonalization in today's large institutions. A computerized scheduling system at Purdue University, for instance, gives each student a chance to pick the professor he wants for every course. Consequently, students get their first choice of professors about 78 percent of the time, against about 22 percent under the old manual system.

Students should be given enough realistic information about computers to separate fact from fantasy. They should be able to overcome fear of the unknown—the fear that makes people resist some of the most valuable computer applications. On the other hand, they should know enough to spot the danger in case technology is misapplied. Students who have daily contact with computer techniques in their high schools and colleges will probably learn most of this by osmosis.

Until now we have just been experimenting with computers in education. With the regional approach described in the feasibility study, however, it should be possible to provide high powered computer services to the schools in the very near future. Judging from the number of schools experimenting with such methods even before they were economical, I'd predict this system will be in a large number of schools in the early 1970's.

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Nevertheless, educators should keep an eye on some of the more exotic computer applications because these, too, may be economically feasible in the next decade. On the administrative scene, computers may alter our entire concept of the classroom with their fantastic ability to reschedule classes. New flexible scheduling systems make it possible to reschedule an entire high school every two weeks, so that every student is almost always in a "class" that suits his individual needs.

Purdue University uses the computer to plan new buildings. It takes various proposed building layout options on the basis of projected number of teachers and students for each course and juggles them to design the most effective facilities. Purdue claims the system has saved about $30 million over the past five years. The same principle should work just as well for high schools.

Computers will be shaping what goes on in the classroom as well as the building where learning takes place. They will be grading papers, giving tests, and in many cases, actually teaching the students. One of the most time-consuming tasks in professional education, the grading of English papers, may be taken over by these instruments. Imaginative researchers at the University of Connecticut have come up with the surprising but well-confirmed result that a computer's grading and comments on essays are indistinguishable statistically from those of the English professors. (I have not fully resolved in my own mind whether this is a comment on the computer or the professors.)

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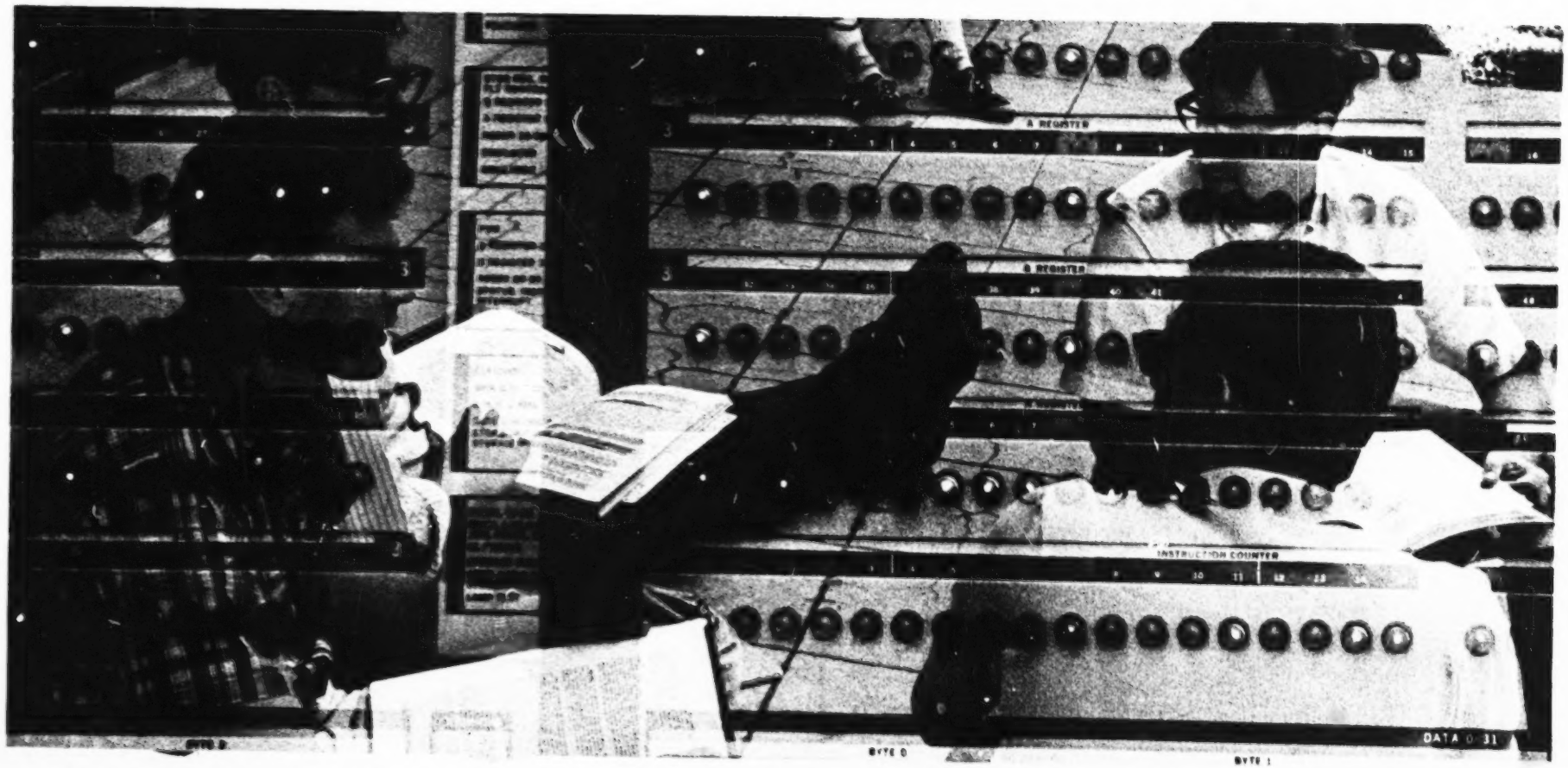
The New York Institute of Technology has been using a system that points up the computer's possibilities in instruction management. Each student pursues self-study in a standardized college text and takes a multiple-choice quiz over each unit. He feeds his answer sheet into a computer which does three things: It keeps his record current, indicating missed questions and correlating them with past errors to detect a pattern that may guide his adviser. It provides data for updating the curriculum by analyzing the responses to the questions to determine whether some are giving unexpected difficulty to certain types of students. And last, it hands the student a list of questions he missed, naming three extra tests and the page numbers where the same material is presented by a different author. If he scored 85 or better, he gets a new assignment; otherwise, he must look up the references and retake the test.

Such computer uses will give teachers more time to help each student individually in ways that are inconceivable in traditional classrooms. Freed from routine chores like recordkeeping, grading, and drill and practice exercises, the teachers will have more time to teach. They'll do things the machine can't do: teach students to speak effectively, to express their ideas, to communicate with others.

Perhaps the computer's "human" qualities stand out best in computer-assisted instruction, where



The Time Is Now—continued

the machine can tailor instruction to the needs of each individual. In teaching reading, for instance, the machine can help each student form sounds or recognize letters. Through audio and pictorial messages, it can reach children who have never seen the alphabet or the number system. And the computer never loses its temper—a characteristic that is extremely valuable for teaching young children.

Computers are also effective teachers for illiterate adults who may feel too humiliated to take advantage of what educational opportunities they have. The computer can't embarrass them; it deals with them individually with no critical human eye to watch their performance. The machine also acts as a "contingency reinforcer"; it can reward a student immediately for work well done. If the lesson is too tough for him, it prescribes material where he can be successful. This instantaneous reward technique shows striking results in motivation.

machines enables investigators to follow many avenues that were blocked when they were restricted to the old desk calculator techniques. The impact is felt in every quarter of social and education research through new possibilities for vast statistical correlations. But computers can do far more for researchers than handle data. They are sharp detectives of the many obscure, elusive processes that are a part of learning.

Thanks to the computer, physiological research is beginning to unfold much hidden information about the learning process. Continuous monitoring of eye movements may reveal unsuspected reading difficulties. Eye dilation seems to be a measure of comprehension and blood pressure may indicate how much effort a student has to put into learning. All these movements can best be traced by computer.

I believe the computer has real potential for teaching art and music. In addition to teaching

research must answer. What characteristics of the machines are most valuable in the classroom? What special language will enable curriculum people to insert course material into the machines with ease and retrieve data on student performance? What will the teacher's role be like in the computerized classroom? What problems would arise from vast information retrieval networks concerning copyrights, privacy, and regulatory necessities? Such questions will undoubtedly be the subject of careful study.

In the meantime, however, there is no point in concentrating on the problems while opportunities for using computers slip by. Universities with computerized research facilities tend to do just that; they press for glamorous new developments and ignore the practical services—accounting, data processing, vocational training, and even computer-assisted instruction—that could be offered right now. When they try to do both functions, one or

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School libraries will be feeling the effects of computers soon. Eventually students may not even have to leaf through books to get information. A West Coast organization has already placed an entire child's encyclopedia in a computer so that the youngster can ply the computer with questions like "What do birds eat?" and get a patient answer. A little further in the future, local libraries may be completely transformed. There will probably be a few centralized information centers with vast collections of information on specific subjects. These would be hooked up to the "local libraries"—computerized facilities throughout the country where the borrower would simply request any material he wanted. No matter how obscure, the material would be located, and would travel electronically from the central facility to the local one. Information retrieval would be instantaneous and completely automatic.

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I believe the computer has real potential for teaching art and music. In addition to teaching the rules and structure of harmony, it could teach the discriminations basic to the recognition of pictorial composition and musical themes. And who knows, it might even teach perfect pitch!

The machines can simulate many situations, either by imitating real life or by games. They can mimic the inside of an aircraft, a complex laboratory, or the 16th century mercantile system. Students get a realistic feel for the subject by being involved in it.

In educating the handicapped, the machine can make its communication with the blind entirely verbal; with the deaf, entirely visual. There are psychological advantages: experiments dramatically show that some emotionally disturbed students who reject humans will relate to hardware.

The computer is already an extremely effective teacher of mechanical skills, and experiments indicate that it may soon be a right-hand man to the vocational counselor as well.

I have sketched an exhilarating future for education, where the computer is a mainstay in the classroom, the business office, the library, and the laboratory. While the computer is ready to go to work in many areas, there are still questions that insert course material into the machines with ease and retrieve data on student performance? What will the teacher's role be like in the computerized classroom? What problems would arise from vast information retrieval networks concerning copyrights, privacy, and regulatory necessities? Such questions will undoubtedly be the subject of careful study.

In the meantime, however, there is no point in concentrating on the problems while opportunities for using computers slip by. Universities with computerized research facilities tend to do just that; they press for glamorous new developments and ignore the practical services—accounting, data processing, vocational training, and even computer-assisted instruction—that could be offered right now. When they try to do both functions, one or the other usually suffers. Such institutions may have to utilize two types of facilities, one to supply the institution's operating needs and the other to pursue research.

The Bureau of Research is currently supporting studies in nearly every area where computers touch education. In California and Iowa, the Bureau has supported State efforts to standardize information retrieval systems. There are more than 30 library studies under way under the Bureau's new Library Science and Information Program. With Federal support, computers are being developed for almost every phase of administrative management and they're already teaching children in a number of classrooms throughout the Nation.

Thus, on all education fronts computers are beginning to have powerful impact. I am firmly convinced that within the next decade we will see these remarkable instruments bring about revolution in the classroom and the entire educational process equivalent to the one already wrought by computers in industry. ■

Dr. Bright, formerly with Westinghouse research laboratories, is OE's associate commissioner for research.

The ABC's of CAI

By LOUIS HAUSMAN

Any estimate of the future form of the learning process in our school systems must consider three initials: CAI, meaning computer-assisted instruction. In simple terms, computer-assisted instruction is a means of teaching students, individually, the contents of a course or series of courses through progressive units electronically manipulated.

A course is designed as a series of units that are fed into a central device and in turn, fed out to individual consoles. CAI can—and frequently does—include audio as well as video presentation. Each pupil, in his personal and private cubicle, seated before his own console, gets the question and responds. If he's wrong the question is repeated with hints of the correct response. When the correct answer is given the machine goes on to the next unit.

cally gifted do not get bored by a pace directed at the median student. 3) The usual system, in which a youngster is frozen at a certain level for a whole or half term, is replaced by a daily tracking system, in which a youngster moves up or down each day after each lesson. 4) It permits scientific development of a curriculum by learned societies and teachers. This can have wide applicability; even small rural schools in poverty areas could compete with large suburban schools in breadth of courses available as well as level of competence. 5) It ensures the acquisition of basic skills for children of educationally deprived backgrounds and makes them more teachable as they progress. 6) It provides a complete, instantly available record of each child's achievement and furnishes information for course modification.

How will CAI influence or change the role of the teacher?

First, it can take away the drudgery of rote teaching. Particularly in elementary schools, a teacher's energy and time are constantly drained by the demand for endless repetition. Yet the acquisition of basic skills and facts is the foundation of education.

In a recent issue of "Grade Teacher," one teacher wrote what is almost a testimonial to the need for programed instruction: "At times I think I'll lose my mind. They read so slowly, think so slowly, write so slowly."

Skills and facts can be taught by machines which never tire or get distracted by out-of-school problems, never change their tone, or lose their patience.

Typically, the student would spend only a half hour to an hour and a half a day being instructed by a computer. During this time the teacher is freed to act as a diagnostician, to help individuals who may be having problems.

Computer-assisted instruction is one more development in the long continuum of learning aids. Like books and films and records, it multiplies instruction and extends the reach of mediocrity as well as of excellence. One thing CAI can do superbly is to increase the capacity of the individual to learn.

But for all the computer's prowess, it cannot

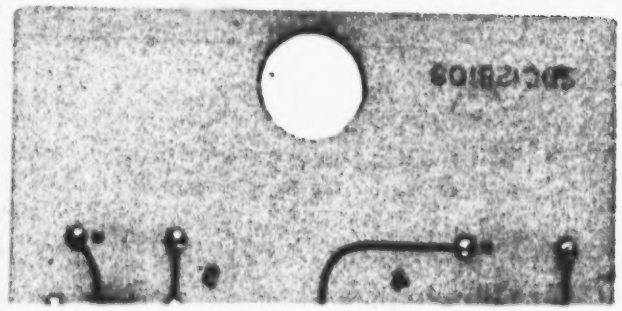
revolution of the 19th century moved society as far as it had progressed since the beginning of history. The advent of the machine aroused two fears: the fear of unemployment—proven groundless—and the fear that the individual as a craftsman would cease to exist, a fallacy which has taken longer to disprove.

The electronics revolution of the mid-20th century has raised similar concerns. But there seems little question that, in the long run, the electronic revolution will create more jobs than it eliminates —jobs of more interest and variety, which require a much higher order of human skill and which foster the concept of the worker as a person with dignity, rather than as a clever animal.

Of more immediate consequence, the electronic revolution will give teaching skills a new priority and value, relieving the teacher of many tasks that are only incidentally related to education. The teacher operates at least part of the time as a human data processing machine: counting heads, grading papers, filing reports on everything from truancy to crayon inventory. Now the electron will relieve the teacher of the chores that a machine can do better, and free her for those assignments which only human beings can do.

In this process, the machine—traditional enemy of the individual craftsman — will emancipate teachers and restore them to the dignity and fulfillment which is integral to their functions. For this paradox, those who believe in the democracy of education should be grateful. ■

Mr. Hausman spent 25 years in broadcasting before coming to O[illegible] in 1966 as assistant to Commissioner Howe.



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There are a number of virtues to such a system: 1) The machine never gets tired. It can repeat as often as necessary without losing its temper or needing a coffee break. 2) It is a private system in which the individual proceeds at his own pace. The slower learners are not embarrassed in front of their quicker peers; the more academi-

patience.

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But for all the computer's prowess, it cannot reinforce curiosity, inspire creativity, or develop interpersonal attitudes. This is the unique role of the teacher. For only a human being can teach esthetic perception and understanding, the elements of genuine learning.

We are now, it would seem, at the closing of the circle. In a few short years the industrial

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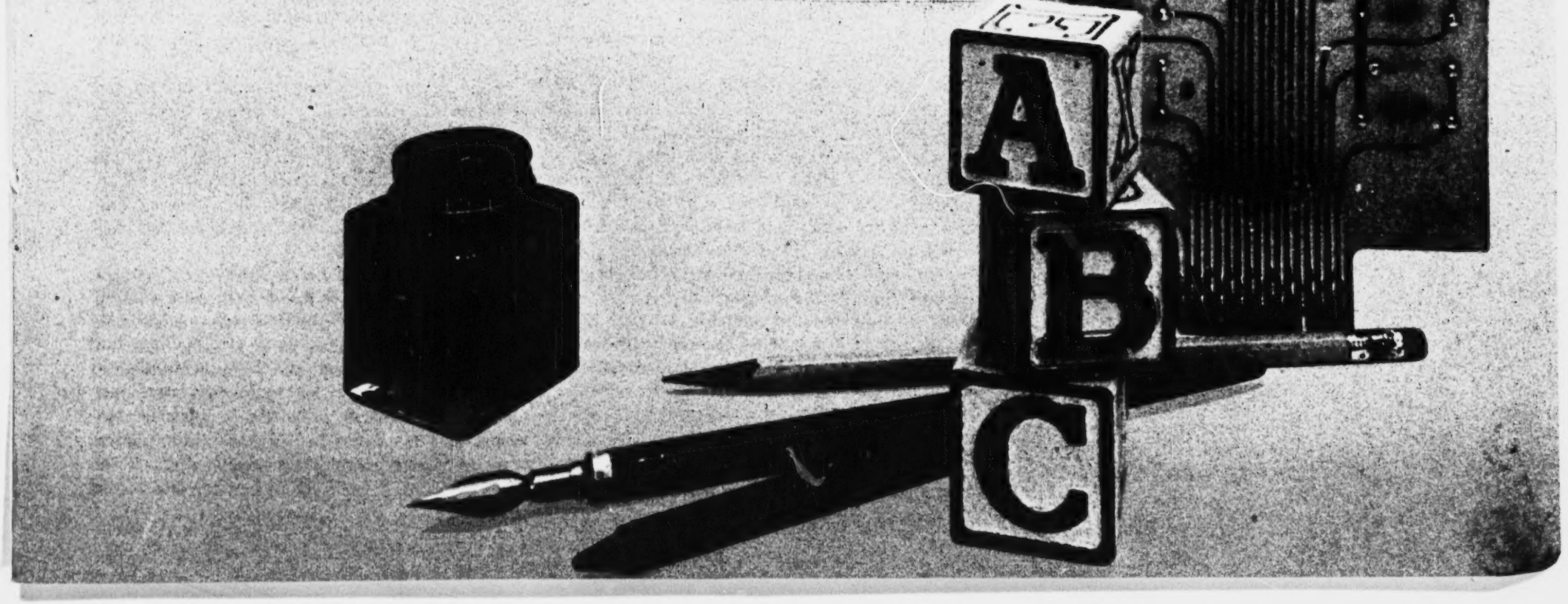
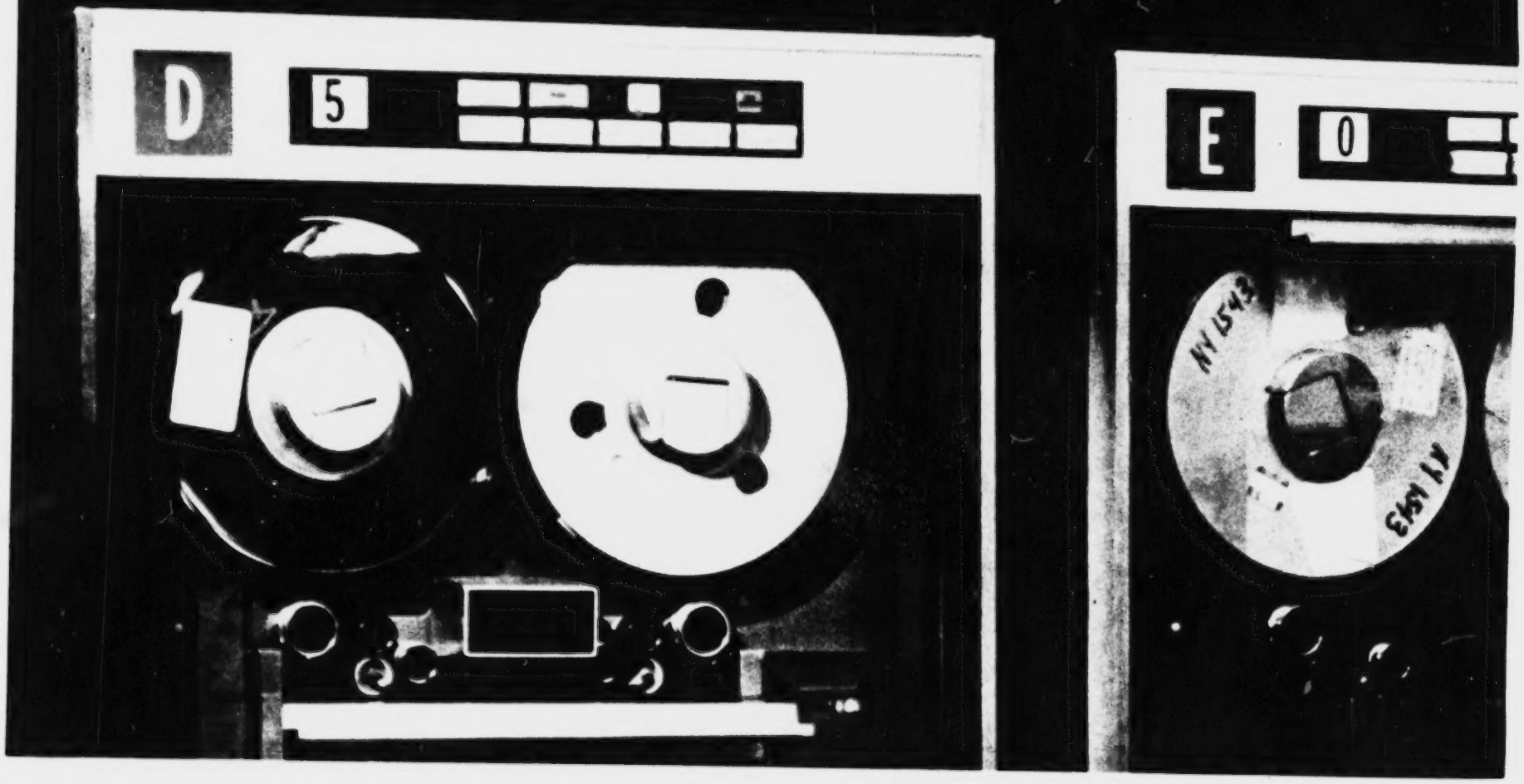


THE VERSATILE COMPUTER IS A



Counselor

It won't be long before high school students will be able to confide their career aspirations to a computer and get intelligent guidance. They'll find the machine a responsive "conversationalist," able to draw from its vast store of data all sorts of pertinent facts and figures about education, training, and work opportunities to help them make realistic career decisions.

At least that's the expectation of David V. Tiede-

STUDENT—Yes, my cousin is a scientist.
COMPUTER—Tell me what you think you have in common with that person.
STUDENT—I like to work in a laboratory, discovering things.
COMPUTER—Then we can say you have at least one common interest. What abilities do you have in common?

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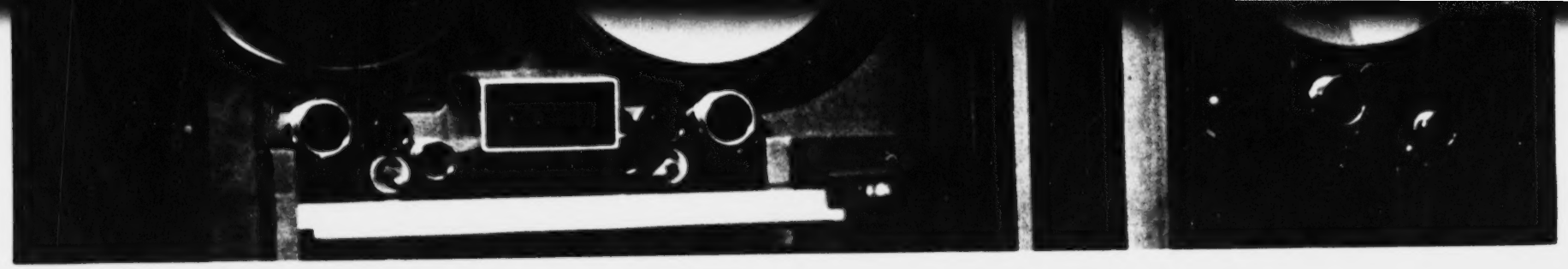

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At least that's the expectation of David V. Tiedeman and his colleagues at Harvard, who are developing and testing an "Information System for Vocational Decision (ISVD)." The project, already under way for a year, is scheduled to be carried through two prototype stages and to be operational in early 1969.

Will the computer make decisions for the student? "No," says Dr. Tiedeman. "Rather, it helps him make his own career choice by giving him a better background of information and sharper analytical tools. The real guidance system is developed in the student, not in the machine."

Information about careers, jobs, industries, courses, suitable schools, and expenses is fed into the computer, along with relevant data about the student's background, his likes, dislikes, academic record, work experience, and so forth. When the student consults the machine, the answers come back by typewriter or earphones or such visual devices as television, films, or even cartoons.

Dr. Tiedeman says that a typical conversation might go like this:

STUDENT—I want to be a scientist.

COMPUTER—Then perhaps you have known someone who was successful as a scientist.

STUDENT—Yes, my cousin is a scientist.

COMPUTER—Tell me what you think you have in common with that person.

STUDENT—I like to work in a laboratory, discovering things.

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Through such dialogue the computer will suggest suitable career choices and tell the student what kind of education and training he needs before entering a particular career. Along with his computer conversation, however, the student will generally receive additional instruction from teachers and vocational counselors, who will interpret the computer responses and help him actually plan his career.

Early in the operational phase of the project, Harvard researchers will eavesdrop to try to learn how students make their original career choices and how the computer-provided data influences their final choices. The investigators will also attempt to define the relationships between students, career choices, and subsequent job performance.

ISVD is part of the New England Education Data Systems and the basic models will eventually be put to much broader use than career orientation and guidance. They can be a valuable asset in local job placement and occupational forecasting, for example. As the information explosion continues and increasing numbers of jobs become obsolete, the system should prove helpful in retraining mature persons for second careers. ■

Planner

How many dormitories will State U. need by 1978? By 1988? How many physics labs? Parking areas? Faculty offices? How much space should be reserved for dining halls? Library? What effect will increased enrollment have on the history department, or on the research undertaken?

College administrators have usually answered these long-range questions by guess and by golly because time, cost, and the data processing capacity of humans made it the only practical way. Systematic long-range planning was well-nigh impossible.

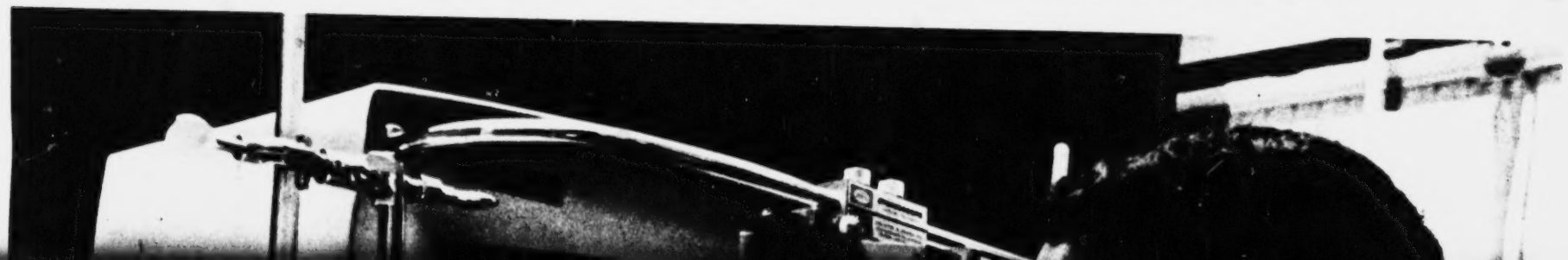
But nothing is impossible in this age of computers. Robert C. Meier, an associate professor in the graduate school of business at the University of Washington, is developing a program that is expected to analyze long-range land, building, and staff needs of institutions of higher learning. With funds from the Esso Foundation and the Cooperative Research program of the U.S. Office of Education, his staff is programing a computer with information about the student body and current operations of the university, to be used as a basis for projections of future needs.

"Actually, our capacity has grown far beyond what we first envisioned," says Dr. Meier. "Originally, we thought we would only be able to project land, facility, and personnel requirements. Instead, we are able to take virtually any body of knowledge, summarize it, and manipulate this information in any direction."

The program operates like a huge equation into which can be inserted variables such as projected population figures, educational objectives, level of service to the community, character of the student body, expected majors, and research. From these data the program can compute such projections as the number of academic credit hours for each department, the need for housing and parking facilities, and the areas where faculty, administrative, and maintenance personnel will have to be shored up.

What about the wide-scale application possibilities of the program? Dr. Meier predicts that this tool will soon be available to administrators everywhere. "With reasonably compatible equipment," he says, "any school could borrow this program and use it for its long-range planning." Each institution would use its own inventories and standards as input. The retrieval language being developed is simple and direct so that little knowl edge of computer programing is necessary.

Quick to point out that the University of Washington program is still at the stage of "primitive research," Dr. Meier nevertheless is optimistic of the future. "Our understanding of what we can achieve is changing rapidly with changing technology," he says. "With the use of third generation computers, remote terminals, and visual display devices (which all universities will have five to ten years from now), this program, and much better ones, will be common. ■



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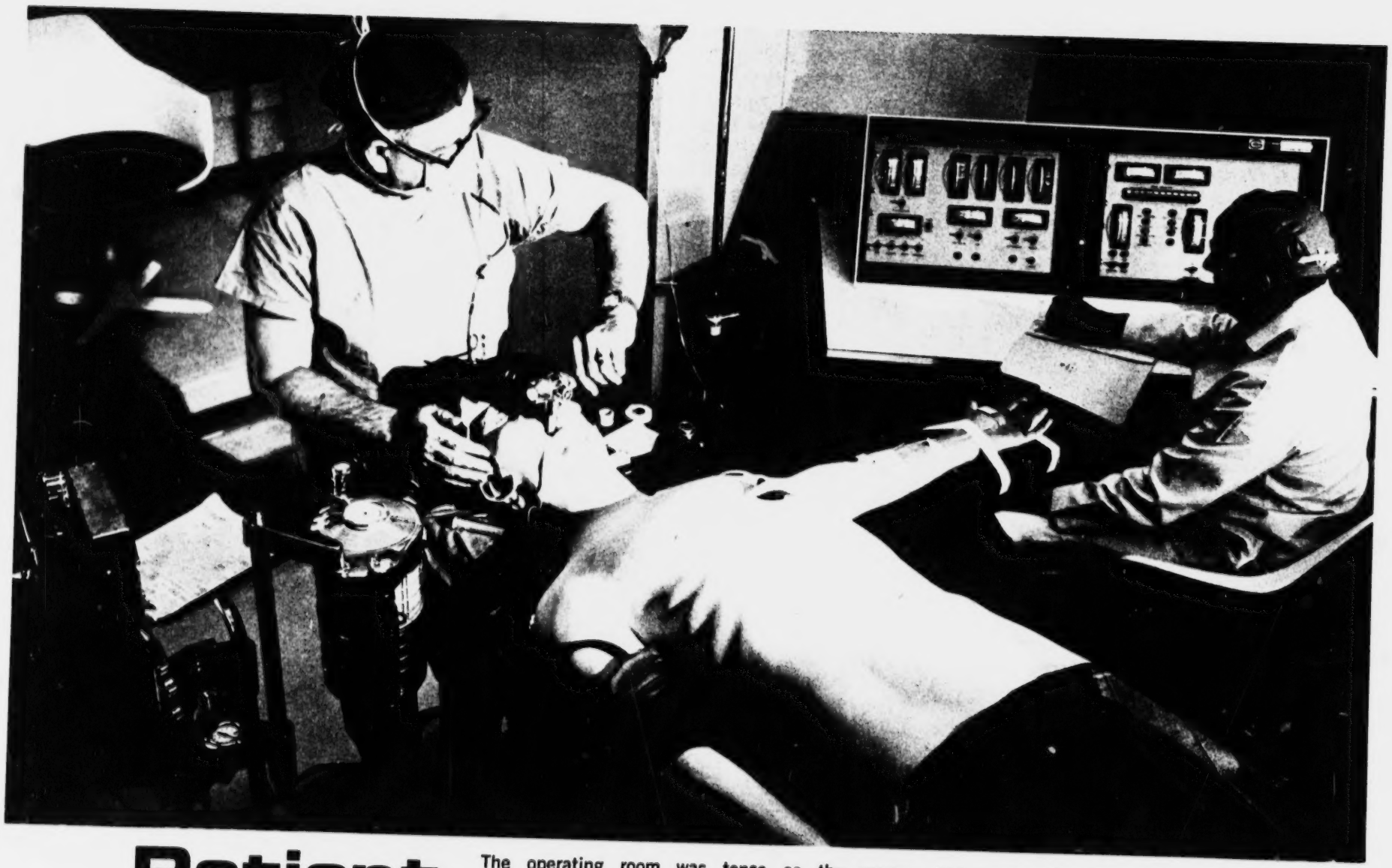

Patient

The operating room was tense as the young doctor administered an anesthetic to his first patient. The patient was doing well—his pulse and breathing were regular; his blood pressure was normal. Suddenly, severe spasms shook the prostrate form. The larynx began to close. Then the patient bucked, attempted to cough the tube out of the throat. Startled, the doctor moved quickly to counter the complications.

But none of the others present seemed much perturbed. This happens all the time at the University of Southern California's School of Medicine. And the patient, named Sim One, is used to complications.

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has many advantages as an educational tool. At any point an instructor can introduce unexpected developments. This affords the student training in a number of emergency situations that he might rarely, if ever, encounter in a normal residency. This, in turn, helps cut the time needed to reach the professional level of performance that USC's J.S. Denson, co-director of the Sim One Project, says resident anesthesiologists should attain.

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Described by doctors as "the most complex medical teaching tool ever devised," Sim One is a life-size computerized manikin used in training anesthesiologists in endotrachial intubation, a delicate technique used in approximately 70 percent of all major surgery. It involves slipping a tube into a patient's windpipe and administering anesthetic gases through it directly into the lungs. The manikin is sufficiently lifelike to represent a human patient awaiting surgery on an operating table. With it, residents can attain proficiency in the intubation technique without risk to human life.

Sim One is programed to give humanlike response to the injection of varying doses of four different drugs. Its electronic "organs" simulate virtually all the symptoms and physiological responses the anesthesiologist might encounter in an actual operation. For example, when the muscle relaxant, succinylcholine, is injected, the manikin twitches just as a human being might. Under other drugs or conditions, the eyes open and close, the pupils dilate and contract, and the mouth opens and closes to reveal tongue, teeth, vocal cords, trachea, and bronchial tubes. Sim One also has a heartbeat, a pulse, and a varying blood pressure. This extraordinary computer-controlled simulator has many advantages as an educational tool. At any point an instructor can introduce unexpected developments. This affords the student training in a number of emergency situations that he might rarely, if ever, encounter in a normal residency. This, in turn, helps cut the time needed to reach the professional level of performance that USC's J.S. Denson, co-director of the Sim One Project, says resident anesthesiologists should attain.

Training time is also reduced by the multiple opportunities Sim One offers for constant practice. Under ordinary conditions a resident usually is offered one or two opportunities to practice endotrachial intubation each day. At that rate, he needs three to six months of practice to become proficient. With Sim One, however, a resident can perform as many as 20 intubations per hour. And the supervisor need not always be present: the computer will print out a record of all work done and indicate any mistakes made. Although the system is still being tested, Stephen Abrahamson, co-director of the project, predicts that residents working with Sim One will achieve a professional level of performance in one to two weeks.

Sim One was developed by USC researchers working with engineers of Aerojet-General Corporation under a $272,000 grant from the Cooperative Research program of the U.S. Office of Education. This past summer residents in anesthesiology at the Los Angeles General Hospital used it to test the feasibility, practicality, and utility of computer-controlled simulated patients.

Sim One's success in anesthesiology is seen as demonstrating the feasibility of teaching all kinds of manual medical techniques with simulators. Sim One and his progeny could assure that when tomorrow's surgeon prepares to operate on his very first patient, he already will have had wide experience. ■

Professor

Approximately 30 Florida State University students have an unusual professor who is also a computer. "He" holds classes at the University's Computer Assisted Instruction (CAI) Center, one of the most advanced in the country, and his subject is Physics 107, a standard three-hour elementary course taken by nonscience majors to fulfill a science requirement. If a student can get through the course without additional help, well and good; if not, he may call on an old-fashioned human type professor for assistance.

"Like the other students, the CAI users must master the material found in a standard physics textbook," explains Duncan Hansen, director of the center. "Unlike other students, though, they attend no lectures. Instead, they come to the CAI Center for three hours of self-directed learning per week."

The computer first introduces the student to a concept or other item of information and then tests him on it. If the student has mastered the material, he proceeds to a successive, more difficult concept. If the lesson gives him difficulty, he is retested and detoured off the main stream of progressive information to a branch designed to give him clarification and individual tutoring on his particular difficulty.

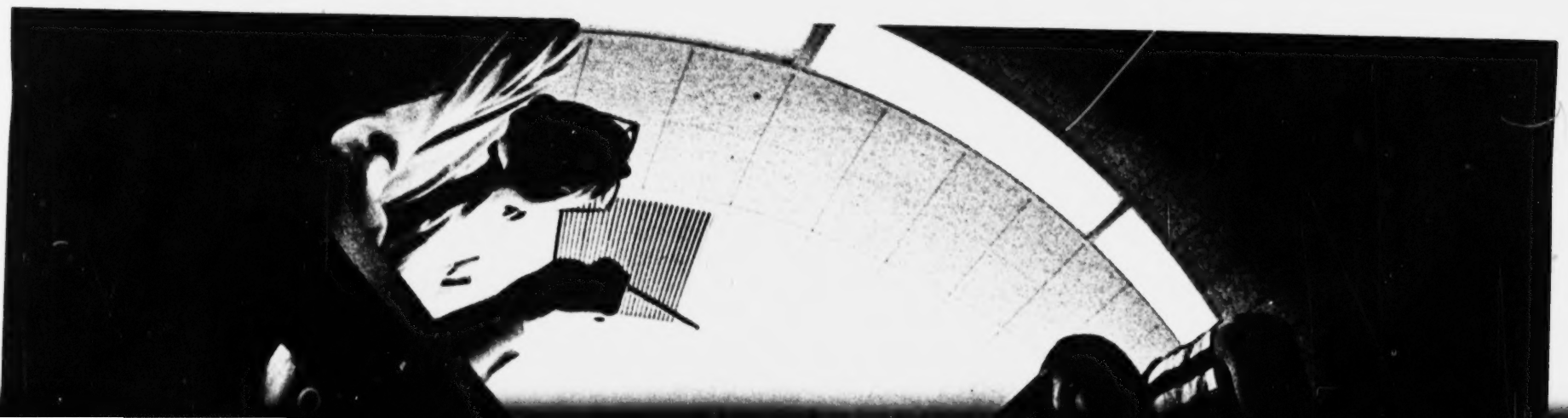
Various media are available to supplement the student's learning: some concepts are presented visually through short films; others are explained more fully in short tapes (12-minute maximum).

The CAI students are graded on the same tests used by approximately a thousand other Physics 107 students. The College Entrance Examination Board has expressed interest in the project and has given FSU a grant to investigate the feasibility of computer-based testing. The main purpose of this research project, however, is to determine whether CAI helps more students to learn more physics more readily.

The computer-professor is popular. Last year, in developing the text material, the physics instructors asked for volunteers to give the program a try. At first some 25 students responded, with the intent of using the sessions as review for their regular quizzes. At each successive call, however, more and more students volunteered, and some 300 eager FSU students were available by final exam time.

How does the future of CAI appear? Promising, says Dr. Hansen, pointing to two valuable possibilities: Florida students could take courses from New York professors, for example. Once terminals are installed, CAI courses can be transmitted across the continent by cable. Secondly, professors could teach large classes of a hundred or more on an individual tutoring basis, for the hours currently devoted to lecturing groups could then be turned to helping students in small group discussion sessions.

More than 98 percent of FSU nonscience majors now want to enroll in the CAI Physics 107 course. This would indicate that even a traditional student terror like physics can, with proper handling, be tamed into popularity. Viva, la machine. ■



Tutor

A little more than a year ago 100 youngsters entering the first grade in Brentwood School in East Palo Alto, Calif., found themselves in the computer age. They are part of a program being conducted by a Stanford University group that wants to find out how well elementary school children learn to read and to work arithmetic problems when their regular patient, pleasant-

dual problems of disadvantaged children and harried or less-than-inspiring teachers. Brentwood itself is in a slum area and has an 80 percent Negro enrollment. Those participating in the reading experiment have an average I.Q. of 89. That these disadvantaged youngsters show such improved performance under computer tutelage suggests that computer-teachers will become an im-

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For the children the experience is like their first dishful of spinach: its not as bad as it looks and it's doing them a lot of good. According to Harlalee A. Wilson, reading project director, the youngsters actually "love the new procedure. They spend only 20 minutes with the computer each day, and teachers have to peel them off the machines to get them back to their other classroom work."

Results, though incomplete, are extremely promising. After less than a year of work, those pupils who had been taught reading by the combination of computer and classroom teacher were several months ahead of their peers in reading ability. They achieved higher marks in the recognition and pronunciation of words, in phonetics, and in vocabulary. Paragraph comprehension was the only skill in which they were not superior, and the difference was so slight as to be negligible.

Brentwood may also have particular significance for slum schools, burdened as they are with the dual problems of disadvantaged children and harried or less-than-inspiring teachers. Brentwood itself is in a slum area and has an 80 percent Negro enrollment. Those participating in the reading experiment have an average I.Q. of 89. That these disadvantaged youngsters show such improved performance under computer tutelage suggests that computer-teachers will become an important new weapon in the educational arsenal against poverty and its handmaiden, ignorance.

Another heartening result of the Brentwood testing is that boys, who traditionally fall behind their female classmates in the early elementary grades, learn just as well as girls in the computer taught classroom. Although various explanations have been offered, the reason for this has not been pinpointed, but the expected learning gap failed to materialize.

For the reading experiment, half of the first-grade pupils are taught by computers in combination with classroom teachers. The other 50 pupils of approximately equal ability act as controls and are taught reading under traditional classroom methods only. In the concurrent experiment in arithmetic, the 50 students who comprise the reading control group are the subjects, and the reading project's experimental pupils take over as control. Both experiments are funded by Cooperative Research grants.

Approximately one year more is needed to evaluate the first phase of the curriculum development. "I look at the first year's run as a long, extended debugging process," says Dr. Wilson. "The real test will come in the 1967-68 academic year when the revised system is tested on a larger scale for a longer period of time." ■

Paper pusher

It takes paperwork to run a school system. Lots of it—student records, class schedules, payroll, inventory, and a thousand and one other items that spell administration. The bigger the system, the bigger the piles of paper. Couple size with stodgy, unimaginative, inflexible organization, and communications channels become hopelessly choked; the system barely limps along, if it doesn't bog down completely.

What a splendid setting this makes for a computer. A computer feeds on paperwork. Its voracious appetite clears the avenues and aisles of debris and transforms catacombs of clerical horror into serene, efficient offices. Many schools suspect this and use computers, at least for routine bookkeeping tasks. More and more administrators are finding other, more imaginative uses for them.

Memphis, Tenn., one of the fastest growing school systems in the South and 12th largest in the Nation with 125,000 students, 132 schools, and a personnel roster of 8,000, has used electronic data processing for its recordkeeping since 1951. In 1961 they automated class scheduling for junior and senior high schools, and one year later did the same for testing and guidance records.

"Gone are the endless lines," says E. R. Holt, director of accounting and data processing for Memphis schools. "Gone is the first-come, first-served, cafeteria-style registration. And gone is the hectic three-day crush of hurried, impersonal counseling.

"In its place the computer has allowed the Memphis schools to substitute a two-month spring registration period and to give each student the individual attention he deserves."

In devising a school schedule all pupil course requests are fed into the computer where they are matched with catalogues of available teachers, courses, and classrooms. During the summer, each school principal receives a suggested master schedule for his school which he can rearrange at his leisure or use intact the following fall.

The program has been so effective that school planners have experimented the past three years with a modular scheduling system. Students at Trezevant High School find their days divided into 20-minute units (or multiples thereof) in place quenced scheduling" permits them short periods for independent study after units of large group instruction. This system is still in the pilot stage, but teachers, principals, and students alike praise the flexibility it provides.

In another pilot project, 14,000 students in 12 different schools get computerized report cards every six weeks. The computer's memory bank enables the card to show the student's earlier grades in any subject, as well as his standard mark for the regular report period. The system also furnishes principals, teachers, and guidance counselors with special reports on outstanding students, along with reports on those in academic difficulty.

Computers have greatly simplified the detail required for inventory analysis and servicing. In order to save money through volume purchasing of cafeteria, custodial, instructional, and maintenance supplies, the Memphis school system maintains and operates 430,000 square feet of warehouse space. Teachers needing supplies get delivery within a few days of their purchasing request. Because the computer keeps records current, inventories are promptly replenished.

One of the newest uses for the computer is updating and improving library offerings. Librarians at individual schools order on preprinted forms and the acquisition of new books is made much easier. The borrower card, spine labels, and catalogue cards for new books are printed on the computer. So effective has the system been that Jack Merrill, the supervisor of systems and computer programing, credits it with part of the success for Memphis' recent second place award from Encyclopaedia Britannica for "greatest library improvement."

For planning purposes Memphis has also conducted a computerized census of all preschool children and has developed and employed a computerized evaluation of inservice teacher training.

Administration still means paperwork and probably always will. But the Memphis experience shows that it need not be an insurmountable problem even in a large school system. The nimble-memoried data processor helps clerks and secretaries fill many requests from their hard-pressed executive bosses more quickly and accurately

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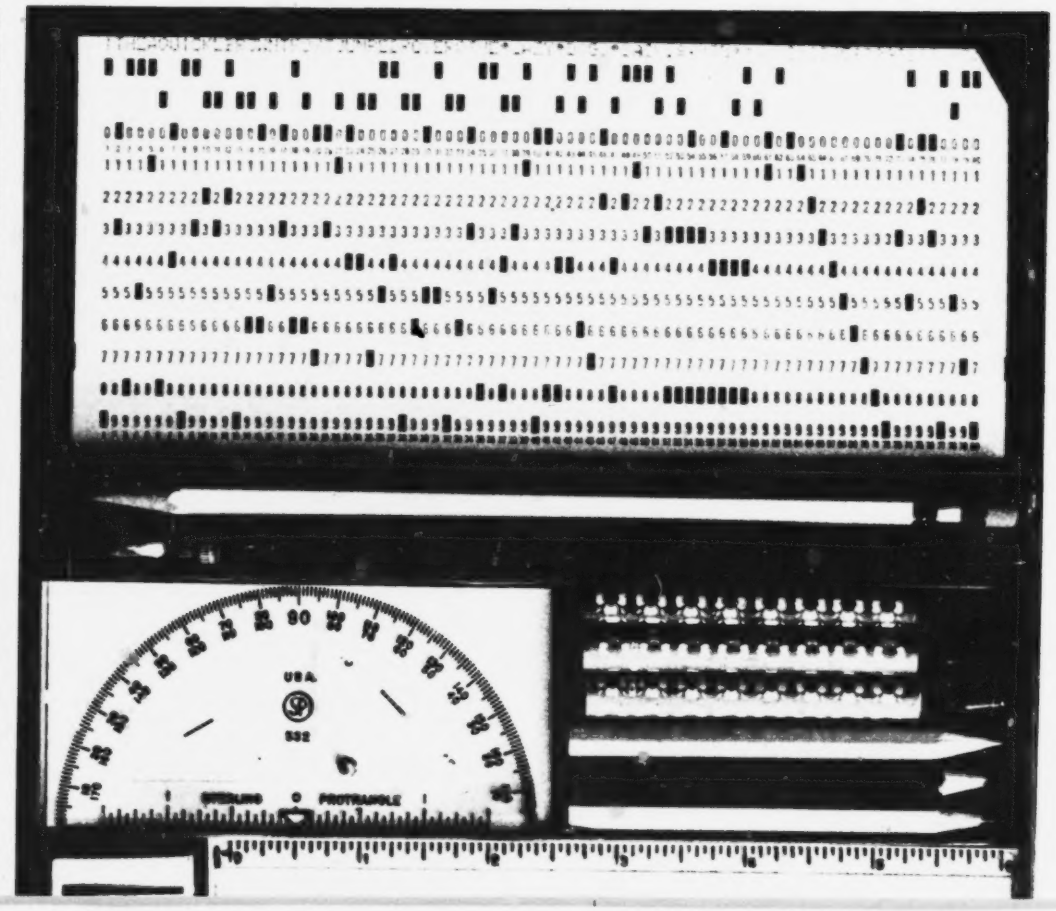


Technology

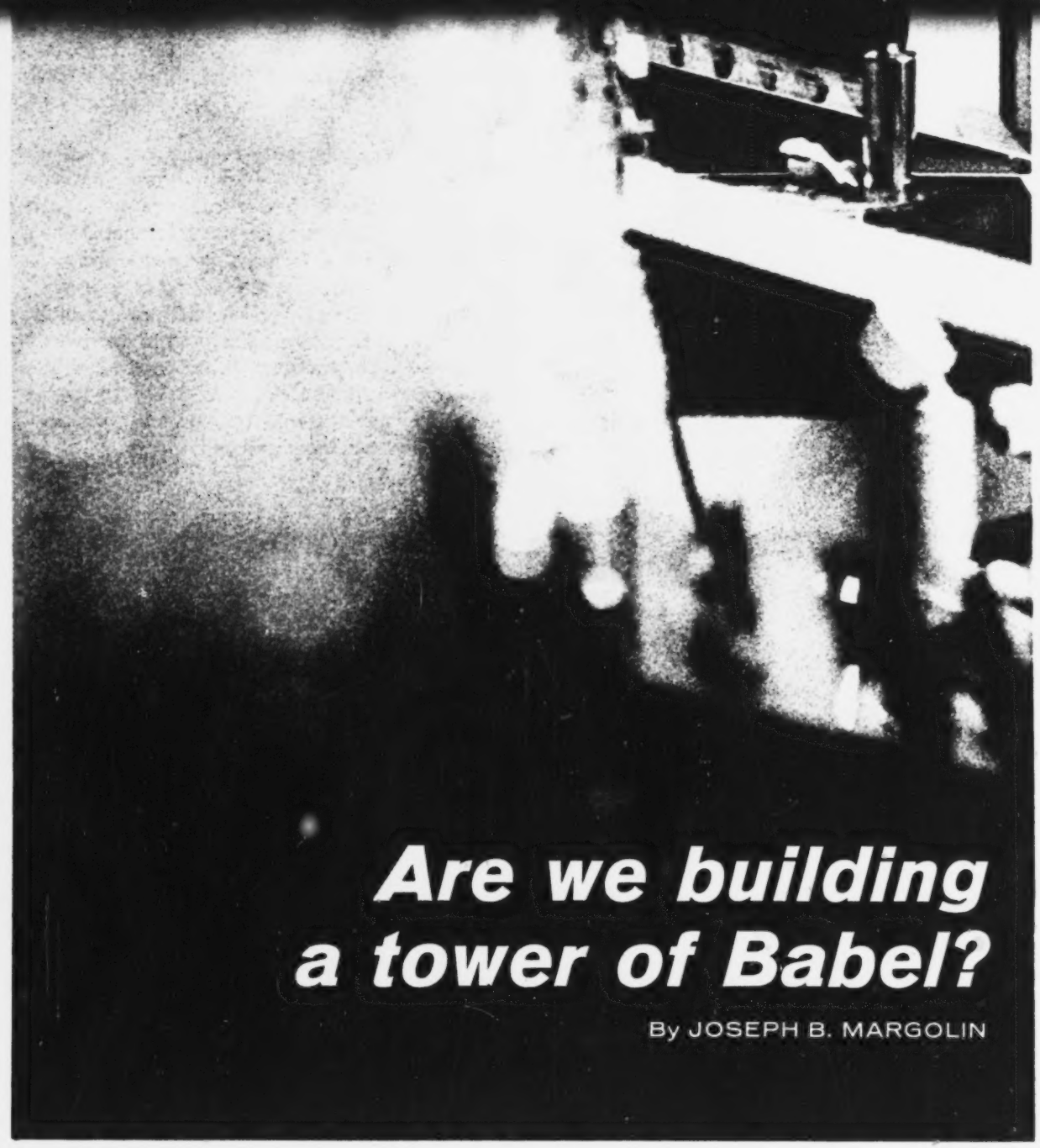
A storm has grown up about the new educational technology. A great computer-based industry with an annual expenditure of 60 to 80 billion dollars is in prospect. Claims and counter claims of what it will do for and to education are exceeded only by the speed with which new developments appear and new summaries of the state of the art are printed. Yet from the towering cloud of dust surrounding the strenuous activity of educators, engineers, industrial salesmen, government experts, and administrators, there should be heard a small voice proclaiming the purpose of it all: to provide conditions more favorable for learning. This is the end. All else is "means."

Actually, of course, it is not that simple. The new technology has broad implications for the teacher, for the educational administrator, for those who finance education, and for the Nation's economy. These implications are not necessarily the same for each. Conflicting philosophies and motivation, communications problems, differences in courage and capacity, could turn the educational edifice into a tower of Babel.

The "state of the art" usually conjures up a picture of flashing lights, cathode ray tubes, and children seated in little cubicles with Buck Rogers earphones and ultramodern light pencils. This is unfortunate. "The art" is not limited to technological devices. The art is educational technology, the art of teaching or helping students to learn.

Some perspective is needed. The computer is a basic advance. With it, man has at his fingers a tool that can automatically do a wide range of complex tasks on command. Wonderful, yet still a "tool."

Computer-assisted instruction (CAI) can provide a rich and varying input and response, sound and systematic educational bookkeeping, new insight into the process of learning and, above all, individual and flexible education.



Are we building a tower of Babel?

By JOSEPH B. MARGOLIN

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Computer-assisted instruction (CAI) can provide a rich and varying input and response, sound and systematic educational bookkeeping, new insight into the process of learning and, above all, individual and flexible education.

The teaching logic of CAI ranges from elementary rote drill design sophisticated "Socratic dialogue" in which the student can ask for information or respond at any time. Which logic is used relates to both the computer language and the hardware used. In view of the high goals and the creativity of researchers in this area, it is easy to see why there has been so great a proliferation of languages, hardware systems, and philosophies.

The implications of this "tower of Babel" that we have created are less easy to understand or resolve. Most certainly, we need divergent thinking and creativity. However, it is also true that there is a unique market for this product. There are in this country 20,000 autonomous school districts, many of which pride themselves on providing freedom to individual schools. Within the schools there are differences in teacher style and student need that may lead to alternate prescriptions. If we are to leave some creativity to the teacher, principal, and curriculum development staff we must establish some compatibility of hardware and software and bases of communication so that the educator, on the line, may assemble his own system, or communicate with others.

The major use of the computer at present—despite the introduction of CAI systems in a few pilot settings—is in the administrative and fiscal areas. Here administrators can draw on business and banking's years of experience and adapt it

to the unique needs of education. Payrolls, budgets, schedules, and inventories benefit from electronic bookkeeping. Increasingly, school records are moving towards such a system of rapid storage and retrieval. Even dial access libraries are well along. When CAI comes, school personnel will already be familiar with and masters of "the monster." In many places, the capacity for application to instruction may exist, and the outline of a schoolwide system will have been prepared.

The computer may even offer the solution to the scheduling and monitoring of the flood of uncoordinated educational media—videorecorders and players, language labs, and the like—that has hit the campus. As a record keeper, it can help in the vast job of evaluating the effect and organizing the application of these useful, but problem-laden servants. It provides a continuing assessment of the learner's progress as he progresses. For the teacher and the administrator, it will be an efficient scribe taking note of the components and the "gestalt" or configuration of the educational environment provided for the child, as well as their effectiveness.

The gestalt of the educational environment suggests an interesting concept. Perhaps we can create a new kind of "book" for each child. One that takes note of, and is geared to, his perceptual and cognitive style, that addresses itself to his areas of interest and enthusiasm, to his pace and his level of maturity. Such a "book" would exist in the memory of the computer and, where appropriate, could be reproduced by xerography to be taken home for study. Above all, it would be his—the only book of its kind in the world.

With the aid of the computer itself a system of CAI can include the entire school environment making use of the architecture and the organization of the school and educational system as further tools of the educational planner. All of these factors have long been in the mind of the educator. Never before has he had the tools with which to study and apply this multitude of variables.

suggest that the problem is not at all insuperable.

Inservice training in use of the computer is one possible avenue of retraining. Even more basic is the need for the introduction of CAI, dial access, and calculation facilities into the schools of education. These should be the first objects of a combined government-industrial effort to introduce CAI on a large, well-funded basis.

And what of the students? We can already detect the allure of the new equipment in the number of "computer clubs" organized in our schools. The advantages to the student are evident. Continuing involvement in school work at a level and pace that is tailored to his own learning is enough to subtract boredom from education and promote the kind of self-actualization that psychologists prescribe. Rather than foster conformity, it would seem that CAI can enhance the subtle differences between students that are so often smothered by the uniform chant of the linear educational model. In higher education computers can eliminate much of the infantilization of the college student, bound for traditional reasons to a high school-like mode of learning. The use of the computer will heighten his resourcefulness, his flexibility, and his mastery of the subject and of learning.

First examination suggests the end of occupational unemployment and even of skill obsolescence. CAI terminals, readily at hand, can keep the engineer, scientist, physician, teacher, and housewife fully in step with the rapid pace of technological social change.

Yet CAI is not all "gravy." This could also become the age of the dilettante. We might well be faced by too rapid movement of individuals to satisfying or remunerative occupations. There is a potential lack of fit between some elements of the new individualized education and the new society. Emphasis on individual problem solving may ill prepare a person for life in the highly organized and group oriented society of today and tomorrow. Individualized instruction may also be an incomplete concept. It perhaps should also be described

respect for the considerations of incentive and motivation we may have lost sight of the problems of the deviant child and the different cultural groups. If education is to join with urban renewal and other elements of our society in healing some of our major social ills, it will have to attend to the special cultural problems and to the ecology of the learner's life in the process of teaching the whole person.

Two major areas will affect the state of CAI today and tomorrow. The process of programing awaits the breakthrough that will make it less time-consuming and less expensive. The lag in the development of sound programs in a wide range of subjects also derives from the football of financing that has been tossed back and forth among government, industry, and education. A sound consideration of policy governing research and demonstration costs, copyright, and franchise rights will go far to open this bottleneck.

In the corporate world the impact of CAI on the education-relevant industries has already been felt. Electronics and publishing companies merge like sodium and chlorine ions in a drying salt solution. Printing is rapidly being automated and computer typesetting may endure just long enough to be superseded by direct electrostatic printing. In short, rapid obsolescence will produce many problems in the education and communications industries. Rapid retraining of personnel, careful planning of production and inventories by industry, and realistic recognition by government of the costs of rapid obsolescence can get us past a crisis born primarily of the acceleration of our pace of development.

The problem is an economic and social one and it thereby becomes a political one. It requires development of sound policies if we are not to stumble and slide into the third industrial revolution. ■

Dr. Margolin, senior scientist in the Program of Policy Studies at George Washington University, has just completed an OE study, "Education in the Seventies."

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What of the effect on the teacher? The vision of rows of computer terminals displacing the teacher can only be folly when we observe the effect of modern technology in a society that is closer than ever before to full employment. However, CAI will produce changes. The principal change will be in the teacher's role. The nagging concern of the conscientious instructor about the individual attention needed by the slow or the advanced student can be relieved. Armed with more time and more information about the student than he has ever had, he can shift from the role of medicine dispenser to physician, observing the characteristics of the individual and prescribing to his needs.

If he can utilize the computer as an educational vehicle, he will be seen by the learner as the master of the new industrial and intellectual revolution. The example of the teacher is the crowning educational device: it is often the most important thing acquired by the student.

How will this revolution in teaching come about? Can we wave a magic light pencil and transform our teachers? Certainly not. Yet the relative ease with which a few teachers have adapted to CAI-like systems in Palo Alto, Pittsburgh, and Brooklyn

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COMPUTERS IN EDUCATION

With the aid of Federal funds, computer technology is becoming more evident in school and college classrooms, offices, and research laboratories across the Nation. To date, the Office of Education has spent approximately $34 million on research and research-related activities, planning projects, and operational programs which center around the application of new computer technology to educational problems.

Three programs currently support most of OE's computer-related activities. Research projects under title IV of the Elementary and Secondary Education Act (ESEA) and title VII of the National Defense Education Act of 1958 (NDEA), as well as planning and operational programs under title III of ESEA explore the potential of computers in the instructional process and in administration.

An estimated $13.3 million has been provided for the support of over 100 research-related projects dealing with educational uses of computers. The projects, 60 of which are now active, have been funded through the Cooperative Research Act of 1965 (amended by title IV of ESEA) and title VII II of the Higher Education Act of 1965 authorizes a new library and information sciences research program; and the Vocational Education Act supports a 3-year project at the U.S. Naval Academy for the development of three multimedia courses using computer-assisted instruction and scheduling, a program to place retiring military personnel in vocational and technical education, and a vocational counseling project.

Most computer-related projects fall into six categories, none of which are mutually exclusive: 1) computer-assisted instruction—the study of learning variables as the student reacts to instruction by computer and the development of curricular programs and other software for use in CAI. 2) Programing for specialized data development and analysis—the application of new computer programs to generate otherwise inaccessible data and perform analysis and translation uniquely practical by computer. 3) Computer models and simulation—the use of computers to project and test theories in educational research and statistics and to test alternatives for decision-making in real life situations. 4) Data banks and information retrieval systems—the potential of the computer for

Computer-related projects under title VI, National Defense Education Act of 1958

Investigator/institution	Subject	Grant (FY 67)
Patrick Suppes Stanford U.	Analysis of second-language learning with emphasis on Russian	$159,647 ('66)
Joseph A. Van Campen Stanford U.	Supplemental materials for computer-based first-year course in Russian	104,425
William H. Clark U. of Rochester	Programed foreign language courses in secondary school with specially trained teachers	11,006
Catherine J. Garvey	Developmental testing of a self-instructional French course	64,235
Frederick W. Mote Princeton U.	Research on Chinese linguistics (first of two conferences to aid National East Asian linguistics project)	11,000

Computer-related projects under title IV, Elementary and Secondary Education Act of 1965 and title VII, the National Defense Education Act of 1958 [1]

Category	Number of active projects	Average project cost	Total cost [2]
Computer-assisted instruction	23	$278,563	$6,406,893
Programing for specialized data development and analysis	6	33,588	201,529
Computer models and simulation	5	56,353	281,653
Data banks and information retrieval system	4	183,561	734,347
Computers in administration and organization	13	35,002	455,023
Curriculum and training for computer application	9	40,205	361,847
Totals	60	140,688	8,441,292

[1] Not including research and related activities of the research and development centers and regional educational laboratories, or the ERIC program.
[2] Many projects extend over several years and receive funds in phases, involving funds from more than one fiscal year.

the National Defense Education Act of 1958 (NDEA), as well as planning and operational programs under title III of ESEA explore the potential of computers in the instructional process and in administration.

An estimated $13.3 million has been provided for the support of over 100 research-related projects dealing with educational uses of computers. The projects, 60 of which are now active, have been funded through the Cooperative Research Act of 1965 (amended by title IV of ESEA) and title VII of NDEA.

Since the initiation of ESEA in 1965, 112 individual computer-related projects totaling over $15 million have been approved under its title III to encourage innovation in education. While the majority of these deal with computer-assisted instruction, other projects train teachers, counselors, and school administrators in the use of computers; identify special needs of students so as to provide special services or individual instruction; plan for effective distribution of educational films and audiovisual media; and develop effective class schedules and pupil transportation plans.

Additional computer-related projects are supported under other authorizations: title VI of NDEA provides for a program of research and studies involving the use of computers to improve language teaching and learning; title

software for the ill child. 2) Programing for specialized data development and analysis—the application of new computer programs to generate otherwise inaccessible data and perform analysis and translation uniquely practical by computer. 3) Computer models and simulation—the use of computers to project and test theories in educational research and statistics and to test alternatives for decision-making in real life situations. 4) Data banks and information retrieval systems—the potential of the computer for storage and retrieval of large bodies of information relevant to education and educational research. 5) Computers in administration and organization—uses of the computer in educational planning and management at all levels. 6) Curriculum and training for computer application—development of curriculum and establishment of training programs to aid educators and researchers in making use of computer technology.

Information on the following tables is intended to show the direction and scope of Office of Education support of computer use. Because many projects may run for several years—or less than one—the overall average and total cost of projects is somewhat misleading. However, the figures do give an indication of the range of projects in the various major categories. ■

Category	Number of active projects	Average project cost	Total cost [2]
Computer-assisted instruction	23	$278,563	$6,406,893
Programing for specialized data development and analysis	6	33,588	201,529
Computer models and simulation	5	56,353	281,653
Data banks and information retrieval system	4	183,561	734,347
Computers in administration and organization	13	35,002	455,023
Curriculum and training for computer application	9	40,205	361,847
Totals	60	140,688	8,441,292

[1] Not including research and related activities of the research and development centers and regional educational laboratories, or the ERIC program.
[2] Many projects extend over several years and receive funds in phases, involving funds from more than one fiscal year.

Computer-related projects under title III, Elementary and Secondary Education Act of 1965

Category [1]	Number of active projects	Average project cost	Total cost
Computer-assisted instruction	35	$102,950	$3,603,264
Programing for specialized data development and analysis	18	149,366	2,688,594
Computer models and simulation	3	168,513	505,539
Data banks and information retrieval system	15	132,678	1,990,165
Computers in administration and organization	18	192,800	3,470,409
Curriculum and training for computer application	23	121,942	2,804,660
Totals	112	134,484	15,062,631

[1] Although the majority of these projects do involve computer-assisted instruction programs, title III projects generally tend to overlap several categories. They have been categorized here by what appears to be the major emphasis of each project.

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Title VI of the Civil Rights Act of 1964 states: "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving Federal financial assistance." All programs cited in this article, like every other program or activity receiving financial assistance from the Department of Health, Education, and Welfare, operate in compliance with this law.

Computer related research projects under title IV, Elementary and Secondary Education Act of 1965 and title VII, National Defense Education Act of 1958

Investigator/institution	Subject	Total Cost
Category I: Computer-assisted instruction		
Edgar R. Garrett New Mexico State U.	Speech and language therapy under an automated stimulus control system	$137,988
Dana S. Scott, Stanford U.	New materials for high school geometry	101,546
J. Starkweather, Calif. U.	Science in elementary grades	152,421
Patrick Suppes, Stanford U.	Development of math concepts in children	227,723
R. C. Atkinson, P. Suppes Stanford U.	Primary reading and arithmetic curriculum	920,166
Stephen Abrahamson U. of Southern Calif.	Medical training simulators for anesthesiologists	272,130
Rob Roy, Rensselaer Polytechnic Institute	Boolean algebra and logic design	9,450
Frank Marzollo, Robert Davis Michigan State U.	Programed instructional materials	32,384
J. A. Easley, Illinois U.	Instructional response and analysis	149,696
Mary A. MacDougall Virginia U.	Programed science materials for fourth graders	64,940
Ernest Burkman Florida State U.	Science curriculum grades 7-9	1,618,736
Kenneth H. Wodtke Pennsylvania State U.	Random versus ordered sequencing	8,400
H. E. Mitzel, G. L. Brandon Pennsylvania State U.	Technical education	1,074,081
H. E. Mitzel Pennsylvania State U.	College courses by computer teleprocessing	219,059
Jesse O. Richardson Mass. State Dept. of Educ.	Mathematics	185,421
John F. Cogswell System Development Corp.	Vocational counseling	179,625
T. Smith, E. Smith, E. Hankin Florida State U.	Prevocational education literacy courses	223,387
Gilbert B. Rozran Systems Operation Support	Electronics and auto mechanics	141,108
Duncan Hansen Florida State U.	College physics	236,734
Joseph B. Margolin George Washington U.	Model school systems of the 70's	57,989
Robbin R. Hough Michigan State U.	Systems model of a classroom	9,864
Edwin F. Shelley E. F. Shelley & Co., Inc.	Comprehensive secondary school curriculum	338,585
Ned C. Deihl Pennsylvania State U.	Instrumental music	48,460
Eugene Oxhandler Syracuse U.	Statewide film library network	57,421
Thomas F. Pettigrew Harvard U.	Study of school integration	202,908
Category IV: Data banks and information retrieval systems		
M. Miles, Calif. State College—Dominguez Hills	Communications system for higher education	93,246
Walter J. Foley, U. of Iowa	Educational information project	435,837
Cloyd D. Gull Indiana U. Foundation	Syllabi and bibliographies for college instruction	25,545
M. E. Maron	Bibliographic holdings records in on-line computer systems	179,719
Category V: Computers in administration and organization		
Allen H. Barton Columbia U.	School integration	59,086
F. R. Burnham Iowa State Dept. of Public Instruction	School property accounting system	50,247
Robert C. Meier U. of Washington	Future land, building, and staff requirements in institutions of higher education	7,586
Leonard M. Chaffee Robert W. Zeller New York U.	Cost analysis of automated scheduling	6,800
Gordon Anderson U. of Texas	Student accounting system	8,958
Allen Kent U. of Pittsburgh	Class scheduling	7,620
Morris J. Daniels San Diego State College	Professional occupational adjustment	7,500
D. G. Lewis General Learning Corp.	Central computer for a school system	129,050
J. L. Stone IBM Corp.	Remote-terminal, centralized computer system	85,000
Category VI: Curriculum and training for computer application		
George McGregor Providence College	Instruction for vocational teachers	19,926
Thomas Long Altoona Area School Dist.	Counselor training in statistical analysis	9,867

John F. Cogswell System Development Corp.	Vocational counseling	179,625
T. Smith, E. Smith, E. Hankin Florida State U.	Prevocational education literacy courses	223,387
Gilbert B. Rozran Systems Operation Support	Electronics and auto mechanics	141,108
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Edwin F. Shelley E. F. Shelley & Co., Inc.	Comprehensive secondary school curriculum	338,585
Ned C. Deihl Pennsylvania State U.	Instrumental music	48,460

Category II: Programing for specialized data development and analysis

Ann Schack, Joseph Schack American Printing House for the Blind	Translation of grade 2 braille from print	69,540
Lawrence F. McNamee East Texas State U.	Bibliography of English and American literature dissertations	10,513
Gordon R. Wood Southern Illinois U.	Subregional speech variations	14,492
Calvin C. Nelson U. of Southern Calif.	Braille materials for public schools	9,600
Abraham I. Katsh New York U.	Classification of Hebrew word stems	23,303
Ellis B. Page U. of Connecticut	Analysis of essays	74,081

Category III: Computer models and simulation

Gene V. Glass U. of Illinois	Time-series quasi-experiments	4,256
Donald W. Zimmerman East Carolina College	Relation of multiple-choice test scores	7,128
Arnold Reisman U. of Wisconsin	Flow of Ph.D.'s into higher education	9,940
Gordon Anderson U. of Texas	Student accounting system	
Allen Kent U. of Pittsburgh	Class scheduling	7,620
Morris J. Daniels San Diego State College	Professional occupational adjustment	7,500
D. G. Lewis General Learning Corp.	Central computer for a school system	129,050
J. L. Stone IBM Corp.	Remote-terminal, centralized computer system	85,000

Category VI: Curriculum and training for computer application

George McGregor Providence College	Instruction for vocational teachers	19,926
Thomas Long Altoona Area School Dist.	Counselor training in statistical analysis	9,867
J. William Moore Bucknell U.	Internship and research program as part of graduate program in educational research	33,300
Edward Y. George Bentley College of Accounting and Finance	Mathematics curriculum for under graduate business students	9,000
Lewis E. Wall Colorado State U.	Business data processing summer institutes	14,440
Douglas M. Fellows U. of Hartford	Curriculum for electro-mechanical technicians	76,000
F. Kendrick Bangs U. of Colorado	Implications of automated data processing for educational institutions	153,960
William W. Cooley American Inst. for Research in Behavioral Sciences	Educational research	30,000
James W. Altman	Orientation of educators and behavioral scientists to information systems	30,230
Eliezer Naddor Johns Hopkins U.	Inventory systems laboratory	3,700
Alex G. Morphonios Miami-Dade Junior College	Drafting and design summer institute	19,762
Francis Tuttle Okla. State Board of Vocational Education	Institute to train data processing teachers	35,000
John W. Sullivan Association for Educational Data Systems	Advanced data processing training curriculum	19,878

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